Q.4b) EPS (1) 37871 (A)

$$K = \frac{\text{shunt C}}{\text{self C}} = 0.11$$

Vtg across string, $V = 33/\sqrt{3} = 19.05\ kV$

at junction A,

$$V_2 = V_1(1+K)$$
$$= V_1(1+0.11)$$
$$V_2 = 1.11\,V_1$$

at junction B, $I_3 = I_2 + i_2$

$$V_3 = V_2 + (V_1+V_2)K$$
$$V_3 = 1.342\,V_1$$

i) Vtg across whole string is,

$$V = V_1 + V_2 + V_3$$
$$= V_1 + 1.11\,V_1 + 1.342\,V_1 = 3.452\,V_1$$
$$19.05 = 3.452\,V_1$$
$$\therefore V_1 = 19.05/3.452 = \underline{5.52\,kV}$$

$$V_2 = 1.11\,V_1 = 1.11 \times 5.52 = 6.13\,kV$$
$$V_3 = 1.342\,V_1 = 1.342 \times 5.52 = 7.4\,kV$$

ii) String $\eta = \frac{19.05}{3 \times 7.4} \times 100 = 85.8\%$

$$= \underline{\underline{85.8\%}}$$

Q.3 (b)

(3) (A)

Total R/Ph, $R = 0.1 \times 100 = 10\ \Omega$

Total X/Ph, $X_L = 0.2 \times 100 = 20\ \Omega$

cap. $Y = 0.04 \times 10^{-4} \times 100 = 4 \times 10^{-4}$ S

$$V_R = \frac{10,000 \times 10^3}{\sqrt{3} \times 66 \times 10^3 \times 0.8} = 109\ A$$

$\cos\phi_R = 0.8$; $\sin\phi_R = 0.6$

$\overrightarrow{Z} = R + jX_L = 10 + j20$

i) Taking receiving end vtg as ref phasor

R end vtg, $\overrightarrow{V_R} = V_R + j0 = 38,105\ V$

$\overline{I_R} = I_R(\cos\phi_R - j\sin\phi_R)$

$= 109\,(0.8 - j0.6) = 87.2 - j65.4$

$\overrightarrow{V_1} = \overrightarrow{V_R} + \overline{I_R}\,\overline{Z}/2$

$= 38105 + (87.2 - j65.4)(5 + j10)$

$= 39195 + j545$

$\overrightarrow{I_C} = jY\overrightarrow{V_1} = j4 \times 10^{-4}(39195 + j545) = -0.218 + j15.6$

Send. end I, $\overline{I_S} = \overline{I_R} + \overline{I_C} = (87.2 - j65.4) + (-0.218 + j15.6)$

$= 100\angle -29°47'\ A$.

$\therefore$ Send. end I = 100 A

ii) $\overline{V_S} = \overline{V_1} + \overline{I_S}\,\overline{Z}/2$

$= (39195 + j545) + (87.0 - j49.8)(5 + j10)$

$= 40145\angle 1°40'\ V$

Line value of send. end vtg, $= 40145 \times \sqrt{3} = 69538\ V$.

iii) Ref. to Ph. dig $\phi_1 = 1°40'$, $\phi_2 = 29°47'$

$\phi_S = \phi_1 + \phi_2 = 31°27'$

$\therefore$ Send. end pf $= \cos\phi_S = \cos 31°27 \simeq 0.853$ lag

iv) send end power = $3V_sI_s\cos\phi_s$

$= 3\times 40145\times 100\times 0.853$

$= 10273105W = 10273.105kW$

Power delivered = 10,000 kW

$\therefore \%\eta = \frac{10,000}{10273.105}\times 100 = \underline{97.34\%}$